

## 1.2. **SALSA: AN INTERNATIONAL INTEGRATED EFFORT TOWARDS DECISION MAKERS IN THE UPPER SAN PEDRO RIVER BASIN**

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### 1. INTRODUCTION

One of the main expectations of the SALSA project is the application of knowledge and technological efforts from the scientific community over problems related to natural resources management. Although the main emphasis of the project is given in terms of global changes and mesoscale climate issues, the information that it provides is highly valuable for the solution of conflicts for the utilization of natural resources in a binational watershed like the San Pedro River.

### 2. STUDY AREA

#### 2.1 The San Pedro, an International River

The San Pedro River has its origins in Cananea, Sonora, Mexico, travels north passing the US border, then joins the Gila River at Winkelman, Arizona. The Gila River then joins the Colorado River in Yuma, Arizona, and flows back to Mexico in San Luis Rio Colorado, Sonora, to finally drain into the Gulf of California or Mar de Cortez. Although the San Pedro River's northern limit is the confluence with the Gila, the study area is primarily focused on portion of the basin to the USGS Gage near Tombstone, Arizona (see Fig. 1 in Goodrich et al, this issue).

The watershed has several vegetation types, ranging from coniferous forests on the uplands, to shrubs, and grasslands in the midlands, and riparian vegetation in the lowlands. The riparian corridor is better developed on a river segment from Palominas to Charleston gauging stations. The two most important ecosystems in the area are grasslands and riparian areas because they contain the highest biodiversity and habitat for endangered species. Both countries share the same natural resources but under different physical conditions. The riparian corridor in the US is in

better shape than in Mexico, but in the Mexican side there are more native grasses in the grasslands.

#### 2.2 Environmental protection policies

In both countries there is a call for protection of the natural resources. In the US, the riparian ecosystem associated with a significant portion of the watershed was defined as a unique semi-arid environment and declared a national reserve, the San Pedro Riparian National Conservation Area (SPRNCA) (Bureau of Land Management, 1989). In Mexico, the riparian vegetation and the semiarid grasslands are recognized as outstanding biological elements. The presence of endangered species in both ecosystems led to the proposal of a federal reserve, although no resolution has been made (Morales et al, 1994).

#### 2.3 Ecosystems and man

The desert grasslands and the riparian vegetation has been under pressure by human activities, and many agree that natural resources mismanagement, combined with climate conditions, are the main reasons for the loss of biodiversity, and to some degree for the land degradation, shown by eroded landscapes and less productive land.

Several authors claim that overgrazing was the cause of the disappearance of many native grasses in the watershed and substitution by woody shrubs, as the main vegetation, especially in the US (Bahre, 1995). In Mexico there are still native grasses in the watershed, despite heavy overgrazing. The main reason for this difference could be that the cattle raising was not as intensive in Mexico as in the US, and also that it is more recent. In the US intensive cattle raising started from 1870's (Bahre, 1995), while in Mexico it started in 1906 (Aguilar, 1997). The vegetation changes have also had a

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major impact in the economy of the region. Agriculture and livestock are declining in the local economy.

Riparian vegetation has been in risk due to groundwater pumping (Stromberg et al, 1996) that started in the 1940's in the USA (Vionnet and Maddock, 1992), and in the 1960's in Mexico (Ing. Manuel Contreras Montijo, personal communication). Vionnet and Maddock (1992) used a simulation model to conclude that the cone of depression from pumping in the Palominas, Sierra Vista and Fort Huachuca areas has intersected the river. The results were confirmed by Corell et al (1996).

In the US, the region has undergone significant urbanization, with the main developed water source being groundwater. In Mexico, native grasses are disappearing due to overgrazing, and the riparian ecosystem is also under pressure due to groundwater pumping for agricultural and mining activities. Thus, within the basin, conflict has arisen due to threats to the riparian habitat caused by the groundwater pumping in the Sierra Vista area in the USA, and agriculture and mining in the Cananea area in Mexico.

### **3. The Socioeconomic Component of SALSA**

A water management objective is to have a sustainable development in the area, with quality of life as the main goal. Related to, but part of the process, is the production system, where man uses the natural resources. Man uses the natural resources, but does not deplete them nor abuse them, but uses them wisely. A balance is needed among the different users so land productivity and other natural resources are sustained.

Sustainable development requires the participation of society; therefore, it is important to have input from the population. When the population is involved, we have to recognize that people tend to change their preferences in time; it means that sustainable development is a dynamic process. Also, we have to recognize that decision making is a process that is based on information. If all the stakeholders have the same level of information, then, it is more likely to get consensus for water management decisions.

### **3.1 Approaches**

For water management, there are at least three scenarios: No action, Separated Action, and Integrated Action.

#### *No action scenario*

The no action scenario means doing nothing and let the degradation continue. According to the experience in Arizona, Sonora grasslands will disappear and woody shrubs would be the main vegetation in the lowlands where the remaining native species still exist. In this situation, cattle raising will be least profitable and people would have to either migrate or look for other source of income. Continuing groundwater pumping beyond natural recharge rates would become more expensive because of investments in the deepening of the wells, the energy costs and the loss of a Protected Area, the SPRNCA. Income from the SPRNCA is currently estimated at 2 M\$/yr., and the loss of the riparian area will also result in the disappearance of several species, especially migratory birds, as well as more severe channel incision and reduction of flood control by riparian vegetation.

#### *Separated Action*

If each country works separately, the surface and subsurface flows from Mexico may not be available to improve the environmental conditions in the SPRNCA in an emergency situation. The present state of knowledge regarding the groundwater system indicates that there is little groundwater entering the USA from Mexico, and does not appear to make a significant contribution to the basin water budget in the USA side of the border. More information is needed to substantiate that hypothesis.

#### *Integrated Action*

Joint integrated USA/Mexico analysis of the different decision variables take a decision is high degree of international cooperation. An integrated effort would create a better decision making process, allow differences to come to the negotiation table, identify common objectives, and set water management rules. The advantage is a more efficient program, one that would check for all different possibilities to attain the goals defined. A disadvantages of integrated action is that it take longer because of differences in the legal and institutional systems of the two countries. However, if integrated action is made, it will show not only to

the people of both countries but to an international forum what common interests can do when clear goals are set.

### 3.2 SALSA Impacts on the Action Plan

SALSA is a cooperative research project where scientists from different countries are working together toward the primary objective. The primary objective of the SALSA Program is to understand, model and predict the consequences of natural and human-induced change on the basin-wide water balance and ecological diversity of semiarid regions at event, seasonal, interannual, and decadal time scales (Goodrich et al, this issue). There are many variables included in this research that can help in the decision process.

There are at least two areas where SALSA will have an impact on the region. The first is data, that will provide information of currently unknown variables, since sophisticated equipment has been deployed to analyze information that otherwise wouldn't be available. The second is prediction capabilities through research institutions that have the capacity and the trained personnel to conduct modeling.

#### *Data collection*

To come to this stage, there is a strong need for information of natural resources (inventories and utilization), and human activities from the watershed divide to the outlet. However, the problems in dealing with transboundary projects like this, include the difference on the scale and classification systems used by both countries, compounded by the problems of approaches, and attitudes of people with different points of view and technological development. Vegetation, soils, geology maps are different, and so are the scales used by official institutions, and the time frame for updating data bases. The same is true for socioeconomic variables.

Vegetation is one of the largest water users, and decisions on the protection of natural resources requires the knowledge of not only volumetric demands but timing since in an arid environment a dry spell can make a difference in terms of the existence, modification or disappearance of an ecosystem. The wide variety of vegetation associated with the basin have different physiological behaviors.

#### *Modeling*

Management requires prediction tools like mathematical models that help us provide educated guesses. To analyze the aquifer behavior, groundwater models are part of the tools required; however, a water balance needs to account for the dynamics of the natural vegetation usage. The scientific effort must provide answers in terms of water utilization by vegetation, but also man's utilization and forecast of water consumption must be provided. This will enable the analysis of different management scenarios. Many modeling efforts in the Sierra Vista area started in the 70's and have continued through the present. Those modeling efforts have not included the Mexican portion of the basin for several reasons, the primary one is the difficulty in getting reliable information, and secondly, most aquifer stress in Mexico is distant from the border.

#### *Global Changes Research*

Although the general trend is blaming a combination of droughts and overgrazing for the grassland disappearance, there are many unknowns in the equation. The semiarid vegetation responds not only to summer rainfalls but also to winter rains and snow storms (Martin and Turner, 1977); therefore, vegetation responses to climate is complex and a key issue to set rules for the protection and/or conservation of natural resources.

Droughts and floods are common contradictions in a semi-arid region, and vegetation plays a major role in those processes; therefore, the scientific objectives of SALSA will yield information for better planning of basin natural resources management, and our expectations are in this sense.

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### **REFERENCES**

- Aguilar C., H. 1997. La Frontera Nómada. Sonora y la Revolución Mexicana. Cal y Arena. México, DF. p 150-151.
- Bahre, C. 1995. Human impacts on the Grasslands of Southeastern Arizona. In "M.

- P. McClaran and T. R. Van Devender. The Desert Grassland. The University of Arizona Press. Tucson, Arizona. p. 230-264
- Bureau of Land Management. 1989. San Pedro River. Riparian Management Plan and Environmental Impact Statement. US Department of the Interior. BLM Safford District. Safford, Arizona. June 1989. 381 p
- Corell, S. W., F. Corkhill, D. Lovvik, and F. Putman. 1996. A Groundwater Flow Model of the Sierra Vista Subwatershed of the Upper San Pedro Basin - Southeastern Arizona. Modeling Report No. 10. Hydrology Division. Arizona Department of Water Resources. Phoenix, Arizona. 47p..
- Goodrich, D. C et al. 1997. An Overview of the 1997 Activities of the Semi-Arid Land-Surface-Atmosphere (SALSA) Program. In this issue.
- Martin, S. C., and R. M. Turner. 1977. Vegetation Change in the Sonoran Desert Region, Arizona and Sonora. Arizona Academy of Science 12(2):59-69.
- Morales, G., I.E. Parra, M.T. Sapién, J.M. Cirett, O. Alvarez y F. Laso. 1994. Plan de Manejo de la Reserva de Flora y fauna Silvestre y Acuáticas Sierras La Mariquita-La Elenita-Río San Pedro, Municipios de Cananea, Naco y Santa Cruz, Sonora, México. Centro Ecológico de Sonora. Hermosillo, Sonora, México.
- Stromberg, J. C., R. Tiller, and B. Richter. 1996. Effects of Groundwater Decline on Riparian Vegetation of Semiarid Regions: The San Pedro, Arizona. Ecological Applications 6(1): 113-131.
- Vionnet, L. B., and T. Maddock III. 1992. Modeling of Ground-Water Flow and Surface/Ground-Water Interaction for the San Pedro River Basin. HWR No. 92-010. Department of Hydrology and Water Resources. University of Arizona. Tucson, AZ. 209 p.